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# Effects of Humic Acid and Folic Acid on Sunflower under Drought Stress

***Zohreh Poudineh*, Zahra Ghaffari Moghadam** and Somayyeh Mirshekari*****
**Graduated M.Sc. student of Agroecology,*
***Instiute of Agriculture research University of Zabol*

*(Corresponding author: Zohreh Poudineh)*
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**ABSTRACT: To evaluate the effect of humic acid and folic acid on yield, yield components, and some qualitative characteristics of sunflower under drought stress, an experiment was conducted as split plots in a completely randomized block design with three replications at the Institute of Agriculture, University of Zabol. The experimental treatments included three levels of drought stress: S1 = optimum irrigation, 50% of farm field capacity (control), S2 = 70% of farm field capacity, and S3 = 50% of farm field capacity as the main factor. The side factor included inoculums of sunflower seeds with supplements at three levels: M1 = without inoculation (control), M2 = inoculated with humic acid and M3 = inoculated with folic acid. The results showed that drought could have a very significant impact on 1000- grain weight, number of seeds per head, grain and its biological yield, and harvest index and could increase the rate of solvent carbohydrates and proline content per leaf significantly. This increased drought stress led to an increase in oil content and yield. The results of the study showed that in terms of these factors, drought stress had a significant effect on potassium, but it had no effect on nitrogen and phosphorus. The effect of humic acid and folic acid on 1000-seed weight and seed number per head was very significant.**

**Keywords:** Food complements, proline, oil content, field capacity, yield

## INTRODUCTION

Planting oil seeds has always been a very important part of agriculture in many countries of the world. With recognition of proteins present in these products, an increasing demand for these crops and products rose in the global markets (Saadat Lajevardi, 1981). After cereals, oil seeds are considered as the second most important source of energy required for human societies. These oil pellets constitute a vital part of Tropical agriculture because they are readily available and are highly nutritious food for humans and animals. In their seeds' protoplasts, they own tiny particles of fat (Poor Saleh, 1995). Oil seeds in Iran are very important for the following reasons: 1) higher levels of living and increasing purchasing power, 2) increasing population, 3) better health value in comparison with animal fat, and 4) provision of health care in its processing industry (Saadat Lajevardi, 1981).

According to FAO statistics, the share of sunflower in providing world oil demand is 7.3% (FAO, 2007). Increased focus on the benefits of unsaturated fats in human diet has amplified the use of sunflower oil in edible oil and cook foods. This oil has a bright yellow color and it smells pleasant. One of its most important properties is that under cold temperatures, it does not look opaque (Nasseri, 1991).

Humus compositions of organic matter have two important organic acids called humic acid and folic acid. They are among the humins which vary in molecular size and chemical structure and are extracted from various sources such as soil, humus, peat, oxidized lignite, coal, and so on (Sebahattin & Necdet, 2005). Through chelating the essential elements, humic acid and folic acid not only do not harm the environment but they also increase their uptake and soil fertility (Michael, 2001). In his study, Sladky (1959) observed that application of 50 mg/ L humic acid or folic acid could enhance leaf and root respiration and chlorophyll content of leaves. The present study aimed to investigate the effect of humic and folic acids on sunflower under drought stress in Sistan region.

## MATERIALS AND METHODS

To evaluate the effect of humic acid and folic acid on yield, yield components and some quality characteristics of sunflower under drought stress, this experiment was carried out in a completely randomized block design with split plots in three replications at the Institute of Agriculture, University of Zabol. In this test, three levels of drought stress: S1 = non- stop or optimum irrigation, 50% of farm field capacity, S2 = 70% of farm field capacity, and S3 = 50% of farm field capacity were considered as the main factors. The side factor included inoculums of sunflower seeds with supplements at three levels: M1 = without inoculation (control), M2 = inoculated with humic acid and M3 = inoculated with folic acid. They were performed with three replications.

Thus, the plan was composed of twenty-seven experimental units. The sub- plots were 2 × 3 m and the distance between these plots was 50 cm. These sub-plots included six 3- meter- long lines, 50 cm apart from each other. The main plots and the blocks were respectively 1m and 2m far from each other.

To determine the field capacity, the pressure chamber set was used. The soil samples were collected from different depths of various plots. The saturated samples were placed under 1/3 atmospheric pressure in the pressure chamber set. After reaching the equilibrium moisture content, the samples were taken from the pressure chamber, were put immediately in the laboratory, were weighed by a delicate balance, accuracy of 0.01 g, and were placed in a 105 ° C oven for 24 h. Later, after weighing the dried soil, the field soil capacity was calculated using the following formula:

$$\text{Weight- field soil capacity} = \frac{\text{Container weight with dried soil- Container weight with wet soil}}{\text{Container weight - Container weight with dried soil}} \times 100$$

Likewise, after determination of the moisture and the field capacity, the moisture content of the wilting point was measured at 15-bar pressure. The difference between the moisture of the field capacity and the wilting point moisture was considered as the available moisture. After determining the amount of available moisture, soil sampling and soil moisture levels as well as irrigation day intervals were determined. Irrigation treatments were performed based on soil moisture content for the control treatments of 85%, 70%, and 50%. During periods of stress, soil moisture was measured using TDR and based on experimental treatments; irrigation was performed at certain time intervals. Stress was introduced was 4-leaf stage. Irrigation was done by using flushing in a controlled manner.

## RESULTS AND DISCUSSION

Table 1 shows the analysis of variance. Drought stress had a significant effect (1%) on grain yield. the highest and the lowest rates of yield were obtained respectively in severe drought and in the control treatment. In the latter case, its reduction was 57.8% relative to the control treatment (2-3). The results of some researches indicate a negative and significant effect of water stress on yield and yield components of sunflower seeds, especially in the period of flowering plants. This yield reduction was associated with the impact of drought on grain number and grain weight ((Talha, 1975). Mazaheri Laqab *et al.* (2001) stated that undesirable irrigation regime could not only reduce leaves' areas and their premature aging but it also could lead to loss of function in sunflower seeds.

Analysis of variance (Table 1) showed that using insemination supplements had no significant effect on grain yield. Likewise, the results of Table 2.3 showed there was no difference between supplementary treatments and the control; however, grain yield inoculated with 5887.9 kg folic acid was more effective than other treatments. The difference of letters in each column shows a significant variation.

**Table 1: Analysis of variance for yield and yield components.**

| Treatment | Degrees of freedom | grain Yield (Kg/h) | Biological yield Kg/h) | 1000- grain weight(g) | Harvest index(%) | Seeds per head |
|---|---|---|---|---|---|---|
| Replication | 2 | 494533.98$^{ns}$ | 24276008.33$^{ns}$ | 55.24$^{**}$ | 6.47$^{ns}$ | 6302.48$^{ns}$ |
| drought | 2 | 28690867.58$^{**}$ | 401459172.11$^{**}$ | 592.21$^{**}$ | 39.9$^{ns}$ | 1630760.70$^{**}$ |
| main error | 4 | 1088150.56 | 18952620.44 | 44.27 | 9.18 | 4037.25 |
| Supplement | 2 | 212849.66$^{ns}$ | 21268781.44$^{ns}$ | 69.48$^{**}$ | 0.48$^{ns}$ | 40468.25$^{**}$ |
| Supplementary dryness | 4 | 656642.91$^{ns}$ | 5130999.38$^{ns}$ | 7.42$^{ns}$ | 6.54$^{**}$ | 11133.87$^{*}$ |
| Minor error | 12 | 1679929.32 | 7521112.62 | 12.36 | 13.32 | 3117.11 |
| CV | 2 | 22.47 | 7.89 | 4.14 | 22.72 | 3.84 |

ns, *, **, respectively, not significant, significant at 5 and 1%

**Table 2: Comparison of the means of the major and minor effects of yield and yield components.**

| Treatment | | Grain Yield (Kg/h) | Biological yield Kg/h) | 1000- grain weight(g) | Harvest index (%) | Seeds per head |
|---|---|---|---|---|---|---|
| Drought | S1 | 7824.1a | 42194a | 92.76 a | 18.50a | 19087.78a |
| | S2 | 4871.0b | 32607b | 84.84 ab | 14.83ab | 1386.22a |
| | S3 | 4608.9b | 29345b | 76.54 b | 14.86ab | 1065.44c |
| Supplement | M1 | 5621.1a | 34150a | 81.77b | 16.33a | 1386.33c |
| | M2 | 5755.0a | 33541a | 85.07 ab | 15.94a | 1520.44a |
| | M3 | a5887.9a | 36455a | 87.30a | 15.92a | 1453.67b |

**Table 3: Analysis of variance of osmotic, proline, carbohydrate regulators.**

| Treatment | Degrees of freedom | Proline | Carbohydrates |
|---|---|---|---|
| Replication | 2 | 66.54** | 1.25** |
| drought | 2 | 103.25** | 5.15** |
| main error | 4 | 33.70 | 0.51 |
| Supplement | 2 | 10.70ns | 0.04ns |
| Supplementary dryness | 4 | 7.30ns | 0.034ns |
| Minor error | 12 | 3.57 | 0.060 |
| CV | - | 14.8 | 10.04 |

*, **, respectively, show no significance at 5 and 1%

**Table 4: Mean comparisons of the main and secondary regulators of proline and carbohydrate.**

| Treatment | Level | Proline | Carbohydrate |
|---|---|---|---|
| Drought | S1 | 8.84b | 1.96b |
| | S2 | 14.73a | 2.04b |
| | S3 | 14.68a | 3.31a |
| Supplement | M1 | 13.87a | 2.42a |
| | M2 | 12.68ab | 2.37a |
| | M3 | 11.70b | 2.52a |

The difference of letters in each column shows a significant variation.

**Table 5: Analysis of variance.**

| Treatment | Degrees of freedom | Phosphorous/ grain (%) | Potassium / grain (%) | Nitrogen/ grain (%) | Oil content | Oil yield (kh/ ha) |
|---|---|---|---|---|---|---|
| Replication | 2 | 57.62** | 42.0** | 1.12* | 47.08** | 23789.08* |
| drought | 2 | 8.35ns | 23.34** | 0.05ns | 31.40** | 134091.75** |
| main error | 4 | 55.97 | 15.85 | 0.13 | 49.77 | 11102.51 |
| Supplement | 2 | 0.90ns | 0.07ns | 0.56ns | 12.28ns | 9478.43ns |
| Supplementary dryness | 4 | 8.43* | 0.24ns | 0.22ns | 12.11ns | 8993.08ns |
| Minor error | 12 | 2.45 | 1.50 | 0.23 | 4.36 | 6387.36 |
| CV | - | 15.4 | 9.70 | 18.19 | 5.25 | 10.35 |

*, **, respectively, not significant, significant at 5 and 1%

**Table 6: Mean comparisons of the main and secondary effects.**

| Treatment | level | Phosphorous/ grain | Potassium / grain | Nitrogen | Oil content | Oil yield |
|---|---|---|---|---|---|---|
| Drought | S1 | 9.03a | 14.50a | 2.60a | 41.34a | 891.52a |
| | S2 | 10.81a | 11.82b | 2.76a | 40.23a | 777.09ab |
| | S3 | 10.56a | 11.68b | 2.67a | 37.70b | 647.55b |
| Supplement | M1 | 10.41a | 12.74a | 2.41a | 52.38b | 739.86a |
| | M2 | 10.21a | 12.57a | 2.71a | 84.40b | 771.55a |
| | M3 | 9.78a | 12.61a | 2.91a | 39.91ab | 804.76a |

The difference of letters in each column shows a significant variation.

The results of the comparison of the mean data in Table 2 showed that the highest biological yield was obtained in the control, whereas its minimum level was obtained in 50% of farm field capacity. Biological function of the plant was a good indicator for assessing its growth and yield. Moreover, means' comparison (Table 2) showed that the highest and the lowest 1000- seed weights were observed respectively in the control treatment (no stress) and during using 50% of field capacity. These results showed that 1000- grain yield had a high sensitivity to drought stress, especially during grain filling stage (Majidian *et al.,* 2002). Data analysis (Table 3) showed that drought had a significant effect on carbohydrate accumulation. In addition, comparison of mean data (Table 4) on carbohydrates in leaves indicated similar results in proline. The highest amount of carbohydrates was observed in a drought of 50%.

Analysis of variance (Table 5) showed that drought stress has a significant effect ( 1% ) on oil content. The results of comparing mean data also showed that there was no significant difference between the mild- stress (70%) and severe stress (50%) treatments. In fact, its maximum and minimum effects were on oil content and the control, respectively (Table 6).

Regarding the use of supplements (Table 5), it was observed that these supplements had no significant effect on oil yield and content the table comparing the average data (6) also showed no difference in oil yield and its content.

Just as the results obtained on drought stress, analysis of data variance showed that the use of supplements could not have any significant effect on nitrogen content (Table 5). It is possible to enrich soil by using nutritional supplements and thus, increase production and yield. Humic and folic acids can be used as a new, convenient, and affordable organic fertilizer to increase the efficiency, to strengthen the plant, and to preserve its nutrients. In fact, these acids both directly and indirectly contribute to better release and removal of these elements.

Based on the relevant tables, it was observed that drought stress treatment has a significant effect on qualitative and quantitative traits of the sunflower plant. With increasing drought stress from 90% (control) to 50%, the number of grains per head, 1000- grain weight, biological yield, and harvest index decreased, and consequently, both yield components and grain yield dropped, but no increase was seen in the content of proline, soluble carbon Hydrates and seed oil content.

The results of this study indicated that among supplementary treatments, folic acid had the highest effect on the qualitative and quantitative traits of sunflower plant. It was also inferred that the use of supplements in sunflower plant could decrease the negative effects of drought stress on the quantitative and qualitative features of the plant.

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